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Investigations of the Oyster Beds in Loch Ryan

By R. H. MILLAR, Ph.D., F.R.S.E.

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By R. H. MILLAR, Ph.D., F.R.S.E.
Marine Station, Millport
April, 1963

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CONTENTS

	Page
INTRODUCTION	3
DESCRIPTION OF THE AREA	3
Temperature and Salinity	3
Substratum	3
Bottom Fauna	9
Enemies and Competitors	9
Nanoplankton	10
Native Oysters	10
EXPERIMENTS WITH INTRODUCED OYSTERS	12
Growth	12
Condition	14
Breeding	14
Sampling of Adults	14
Larvae and Spat	14
Mortality among French Oysters	21
CONCLUSIONS	21
SUMMARY	22
REFERENCES	22
APPENDIX	23

Investigations of the Oyster Beds in Loch Ryan

INTRODUCTION

Oysters have existed in Loch Ryan since prehistoric times. A royal charter of 1701 granted the oyster shing rights to a local family but there is little evidence of exploitation before the middle of the 19th ntury. Shortly after this, however, large quantities of oysters were being sold (Young, 1888), and at one me 30 boats were working. The subsequent history of the fishery, which attained a highest recorded tput of over one million oysters annually, can be followed from the graph of landings (Millar, 1961, g. 2). Production has been small since the Second World War, and when fishing was given up as uneconomic a lease was obtained by the Scottish Marine Biological Association. Investigations were then ndertaken with a view to the improvement of the beds and the revival of the fishery. The studies from 958 to 1962 described in the present paper were concerned with the physical and biological conditions the loch and the behaviour of native and introduced oysters.

DESCRIPTION OF THE AREA

Loch Ryan is an inlet $8\frac{1}{2}$ miles long, opening northwards into the southern part of the Clyde Sea rea (Fig. 1, inset). The outer half is narrow, with depths reaching about 16 m (8·7 fm) at the mouth. he inner half averages about $2\frac{1}{4}$ miles in width, and is mainly between 4 and 6 m deep. A sandbank rojecting from the western shore separates the halves and provides shelter to the oyster beds, which are nfined to the inner basin.

EMPERATURE AND SALINITY

A thermograph installed at the end of the west pier, Stranraer, provided a continuous record of the a temperature (Fig. 2). Because the bulb of the thermograph was in shallow water the recorded fluctuations of temperature are slightly greater than in the deeper water over the main beds.

In winter the water temperature often falls below 5°C, but this is not dangerous to oysters, particularly as the salinity remains high. Waugh (1957) found little mortality when water temperature fell below C for more than 30 days, provided that the salinity did not fall seriously. The temperature in Loch yan during June, July and August generally varies between 15 and 17°C, only occasionally reaching °C.

No large rivers enter the loch and only a few small streams drain into the inner basin. Low salinities, erefore, are not to be expected, and the occasional measurements made gave no value under 33·6‰.

UBSTRATUM

The Van Veen grab used in studying the bottom fauna also provided samples of bottom soil. The aterial was taken from the top inch of the grab-sample and the distribution of particle sizes analysed the method of Krumbein and Pettijohn (1938) as described by Holme (1954).The results, expressed as rves of cumulative percentage, have been grouped (Fig. 3) in sets of stations with similar bottom soil

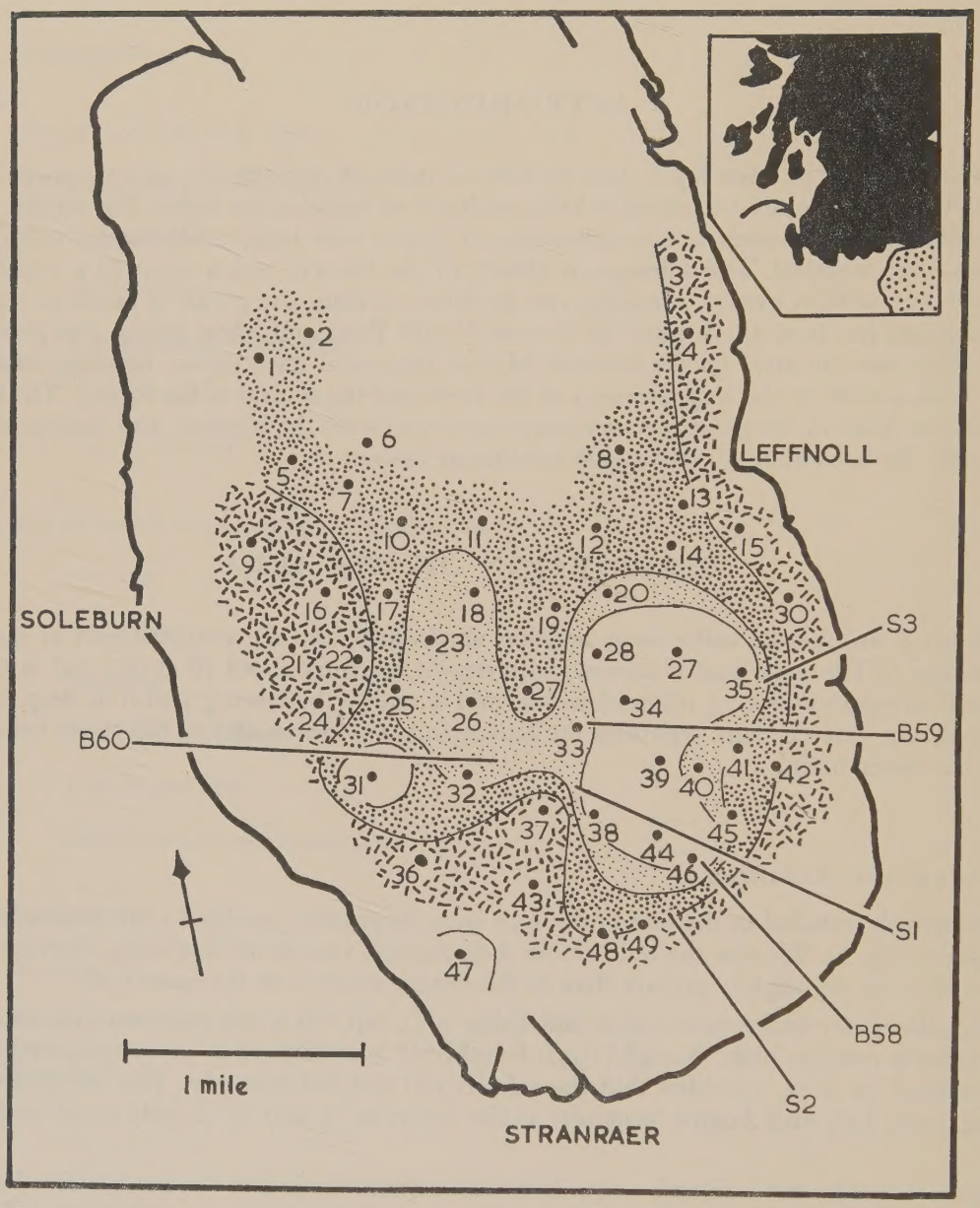


Fig. 1. Map showing distribution of types of bottom material, constructed from results given in Fig. 3; symbols for types of bottom material as in Fig. 3; numbers refer to sampling stations. S1, S2 and S3, positions where mussel shell was laid in 1959; B58, B59 and B60, positions where French oysters were laid in 1958, 1959 and 1960.

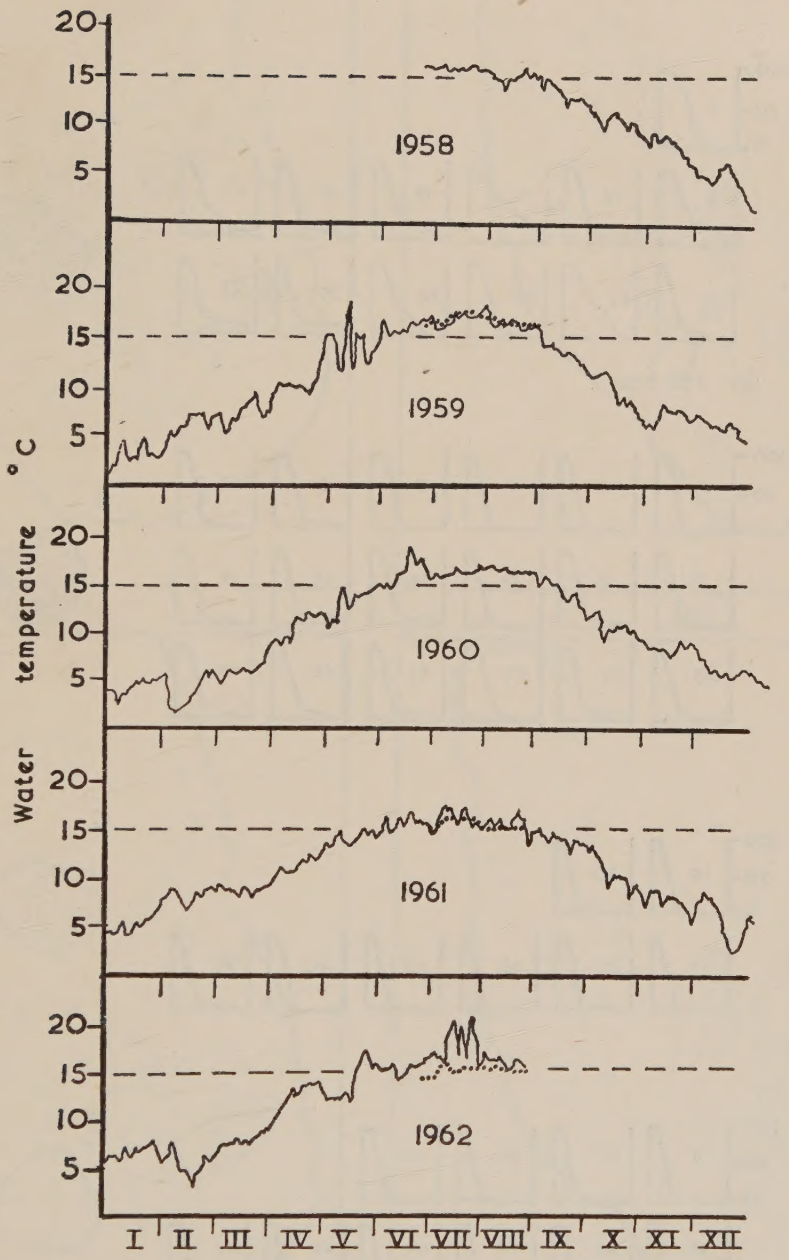


Fig. 2. Water temperature in Loch Ryan; full line is record from thermograph on west pier, Stranraer; dotted line is record from reversing thermometer used over oyster beds at 2 metres depth; broken line indicates 15°C.

and the distribution of bottom soil types has been charted (Fig. 1). The highest percentage of coarse particles is found in the zone nearest the shore, with inwardly projecting areas opposite Soleburn, Leffnol Point and Stranraer Harbour. A muddier substratum occupies the more central part of the inner basin with the softest substratum in the south-eastern area.

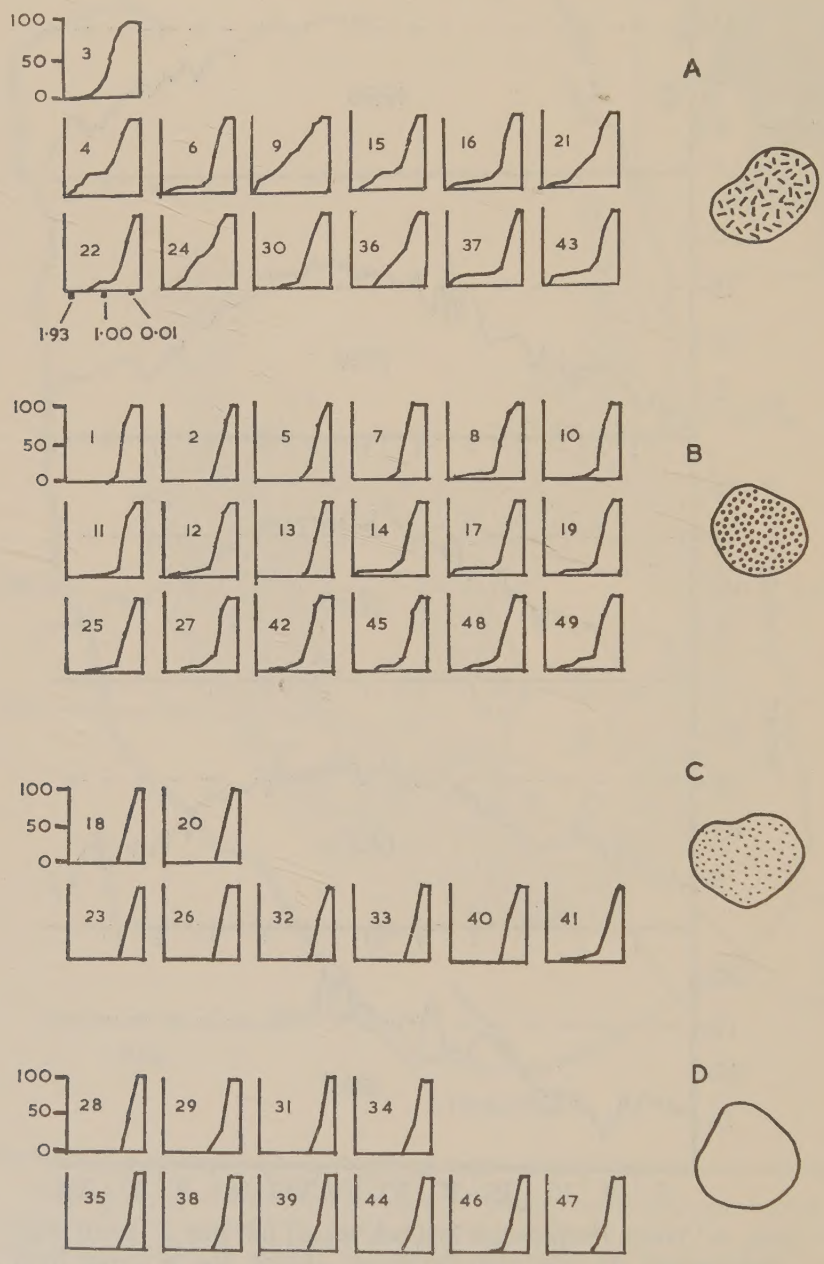
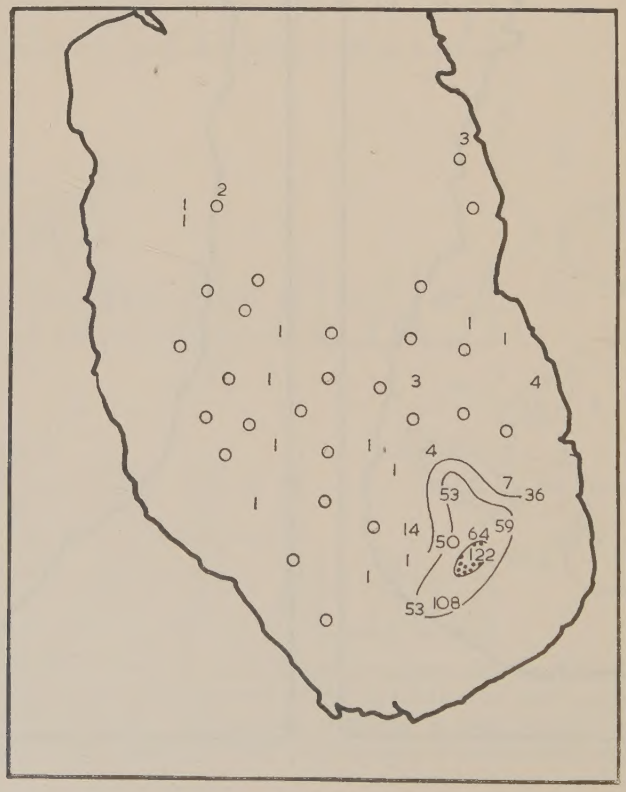


Fig. 3. Cumulative curves of particle-size analyses; station numbers are given on each curve; particle diameter (mm) on horizontal axes; cumulative percentage on vertical axes; stations are arranged in four groups, A, B, C and D, with progressively lower percentages of coarse material.

. 4. Distribution of seven species of mollusc in inner Loch Ryan, showing numbers per square metre and es joining points of approximately equal numbers; the areas of greatest density are stippled. (a) *Turritella communis* Risso, (b) *Abra nitida* (Müller), (c) *Abra alba* (Wood), (d) *Thyasira flexuosa* (Montagu),

(e)

(f)



(g)

Fig. 4. (e) *Venus striatula* (da Costa), (f) *Corbula gibba* (Olivi), (g) *Spisula subtruncata* (da Costa).

The amount of very coarse material was measured approximately by washing the contents of 10 Van Veen grab hauls through a sieve of mesh one millimetre square, and by taking the volumes of the material retained, excluding plants and animals (Fig. 6).

Bottom Fauna

The ten hauls with the Van Veen sampler, when sieved, also yielded the animals living within one square metre of loch bottom at each station. Because the aim of the faunistic survey was to provide an indication of conditions on the bottom, rather than an accurate picture of the bottom communities, only a few species, mainly molluscs living in the upper layers of the substratum, were counted. The results are given in the Appendix, and Figure 4 shows the density-distributions of seven species. Those with similar distributions are grouped as follows:

1. *Turritella communis* Risso
   Abra nitida (Müller)

2. *Abra alba* (Wood)
   Thyasira flexuosa (Montagu)

3. *Venus striatula* (da Costa)
   Corbula gibba (Olivi)
   Spisula subtruncata (da Costa).

The species in the first group are commonest in the central muddy area, *A. nitida* showing a preference for softer ground than *T. communis*. In both species the contours of equal density show close agreement with the contours drawn from the analyses of particle sizes (compare Figs. 4a and b with Fig. 1).

The species in group 2 are most abundant just off the softest ground. Those in group 3 are most abundant in an area generally beyond the south-eastern limit of the central soft ground, and within this group *V. striatula* and *S. subtruncata* are commonest in a more sandy soil than any of the other species studied.

The substratum affects the growth and mortality of oysters (Orton, 1937; Cole, 1956). It should be possible, therefore, to determine quickly the suitability of the bottom for relaid oysters by measuring the numerical densities of the seven species of molluscs, since these densities indicate the nature of the substratum. Further experiments are in progress to determine the relation between substratum and growth in Loch Ryan.

Enemies and Competitors

It has already been noted that the common starfish *Asterias rubens* L. was scarce in two dredging surveys (Millar, 1961). This scarcity was confirmed in surveys during 1960, when 56 hauls with a 3 ft oyster dredge caught a total of only seven *A. rubens*. The crabs *Carcinus maenas* (Pennant) and *Portunus depurator* (L.) are moderately common and may be amongst the more important enemies of oyster spat in Loch Ryan. The boring sponge *Cliona celata* Grant is fairly common in large thick-shelled oysters but seldom appears in younger specimens.

The most serious competitors are probably those which occupy potential settling surfaces before oyster larvae become attached, or which outgrow and smother the spat. Mussel shells dropped on the bottom as spat-collectors in July 1959 were examined at intervals until September 1962. The competitors, in decreasing order of importance, were the barnacle *Balanus porcatus* da Costa, the tubeworm *Pomatoceros triqueter* (L.) and the ascidian *Dendrodoa grossularia* (van Beneden). Barnacles were the most serious competitor for space, and the extent to which they impaired the collecting efficiency of mussel shell is shown

in Table I. The barnacles were almost always present on only one side of the shell, presumably becaus the underside was sufficiently covered by mud to prevent settlement. Mussel shells left on the bottom f a few years become heavily fouled, but during the first year fouling is usually not serious.

TABLE I

EXTENT OF FOULING OF MUSSEL SHELLS BY BARNACLES

Amount of shell covered by barnacles	0	up to $\frac{1}{3}$	$\frac{1}{3}$ - $\frac{2}{3}$	over $\frac{2}{3}$
No. of mussel shells	11	8	36	72

Nanoplankton

Flagellates under 10 μ in diameter constitute the known food of oyster larvae and may also be im portant to the adults. They were estimated from counts on a haemacytometer slide, using dark groun

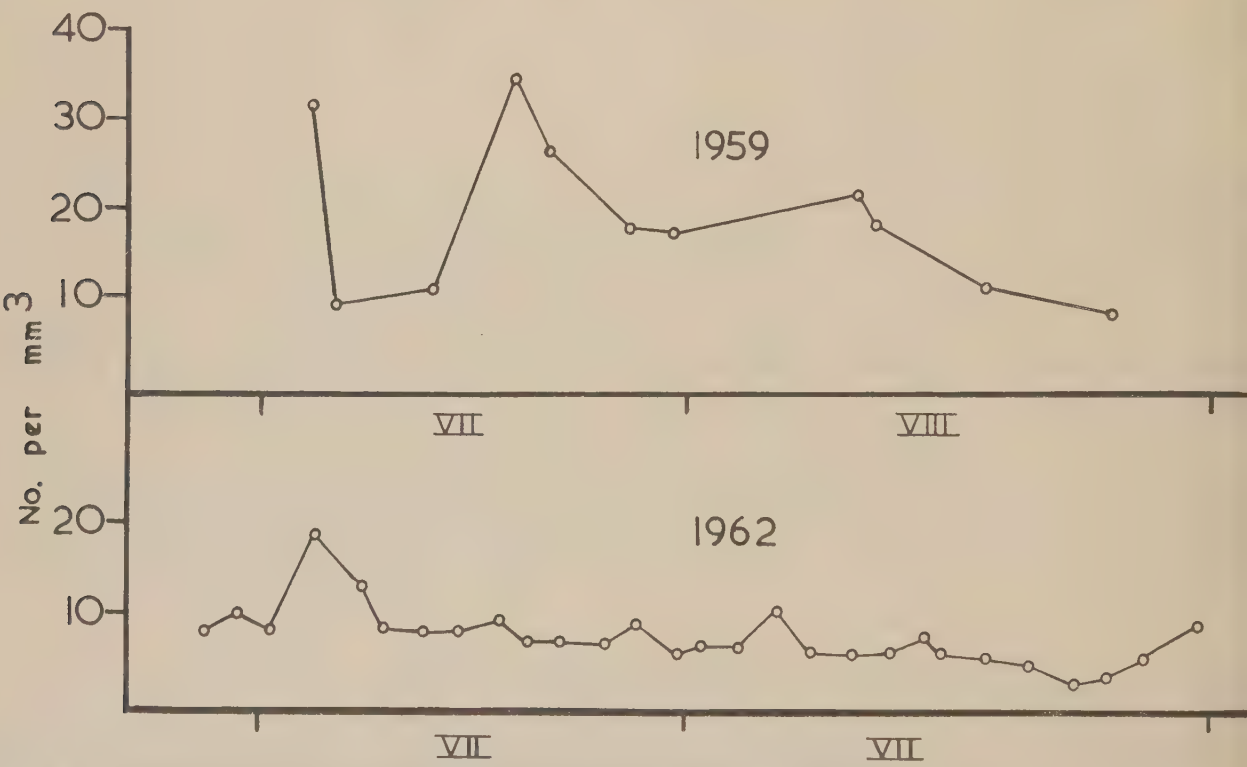


Fig. 5. Nanoplankton in Loch Ryan; number per cubic millimetre of flagellates less than 10 μ in diameter.

illumination. The numbers (Fig. 5) are similar to those recorded over oyster beds in Essex by Knigh Jones (1952) and Waugh (1957).

Native Oysters

The word native, as used here, refers to oysters that have grown from larvae produced in Loch Ryar As no importations had been made for over 20 years before the start of the present investigations, a oysters in the loch when the experiments started are regarded as native.

A series of dredging surveys, which covered the area fairly uniformly, showed the distribution of native oysters (Fig. 6). The figure also shows the areas with relatively large amounts of course particles and broken shell in the soil, where, it appears, native oysters are common. They are not necessarily most abundant, however, where the bottom soil is coarsest, perhaps because these places often have most weed.

Fig. 6. Distribution of native oysters in Loch Ryan as shown by summing the results of dredging surveys from 1958 to 1960; each point represents 5 oysters; the figures on the map are the numbers (x 10) of litres of coarse material retained on a 1 mm sieve, per square metre of bottom obtained from Van Veen samples; the contour lines join points with equal amounts of coarse material.

The weight-distribution of native oysters in 1957 (Fig. 7A) showed the small proportion of medium-sized and large oysters characteristic of an overfished bed. By 1962, after a period without commercial fishing, the proportion of medium-sized and large oysters had increased (Fig. 7B).

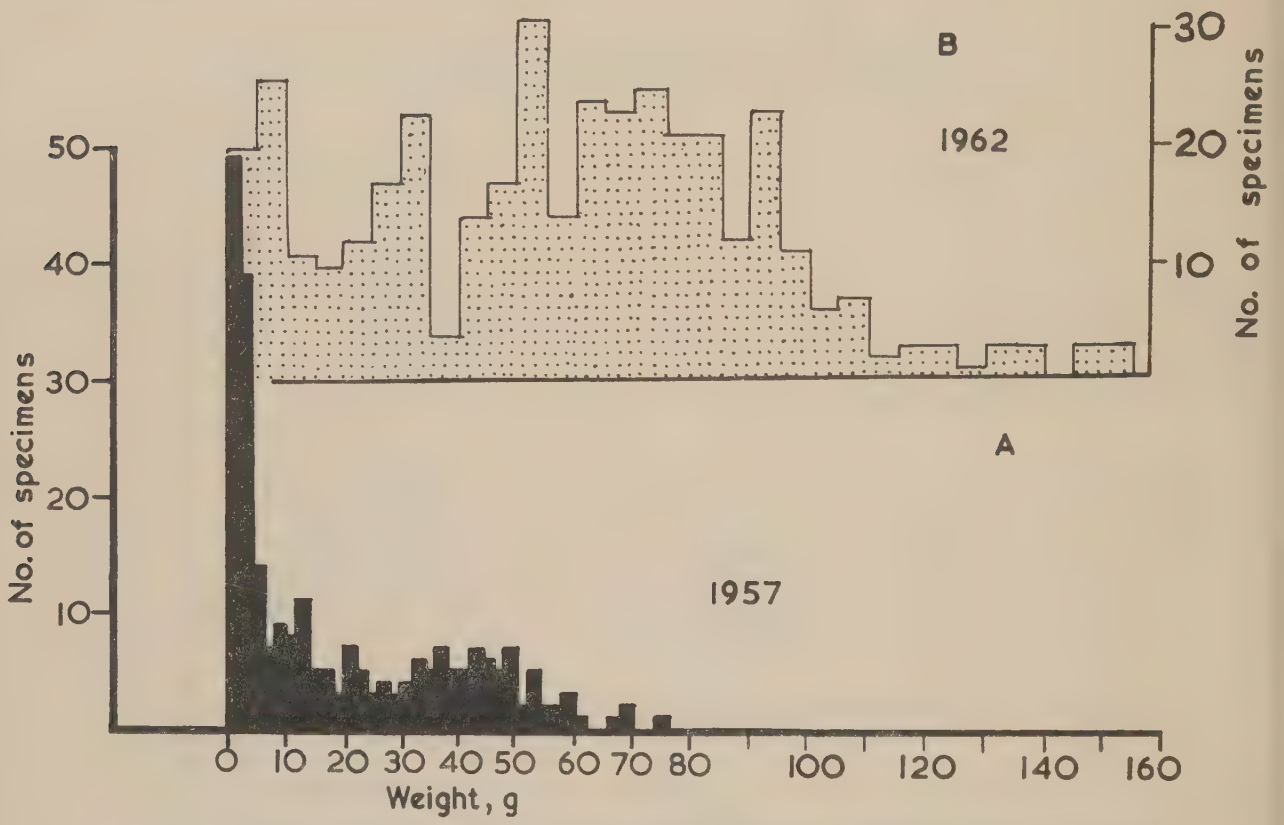


Fig. 7. Weight-distribution of native oysters in Loch Ryan as shown by surveys in 1957(A) and in 1962(B).

EXPERIMENTS WITH INTRODUCED OYSTERS

A small fishery could exist solely on native oysters, but several years would be required to build up a stock to support a moderate or large fishery. As introduced oysters might, therefore, be needed for commercial development, experiments were made with young French oysters from Brittany, in order to study their growth, breeding and mortality.

Growth

Several thousand French oysters were laid in 1958, 1959 and 1960 at places shown in Figure 1. Samples were dredged at intervals and the mean diameter and mean weight determined (Figs. 8 and 9). Little increase in diameter was found after the third year on the beds. The decreases seen in Figure 8 may result from more deaths among large than among small oysters, or from abrasion of shell edges. Although increase in diameter may be greatly reduced or stop after two or three years, the rate of increase in weight is not so markedly reduced.

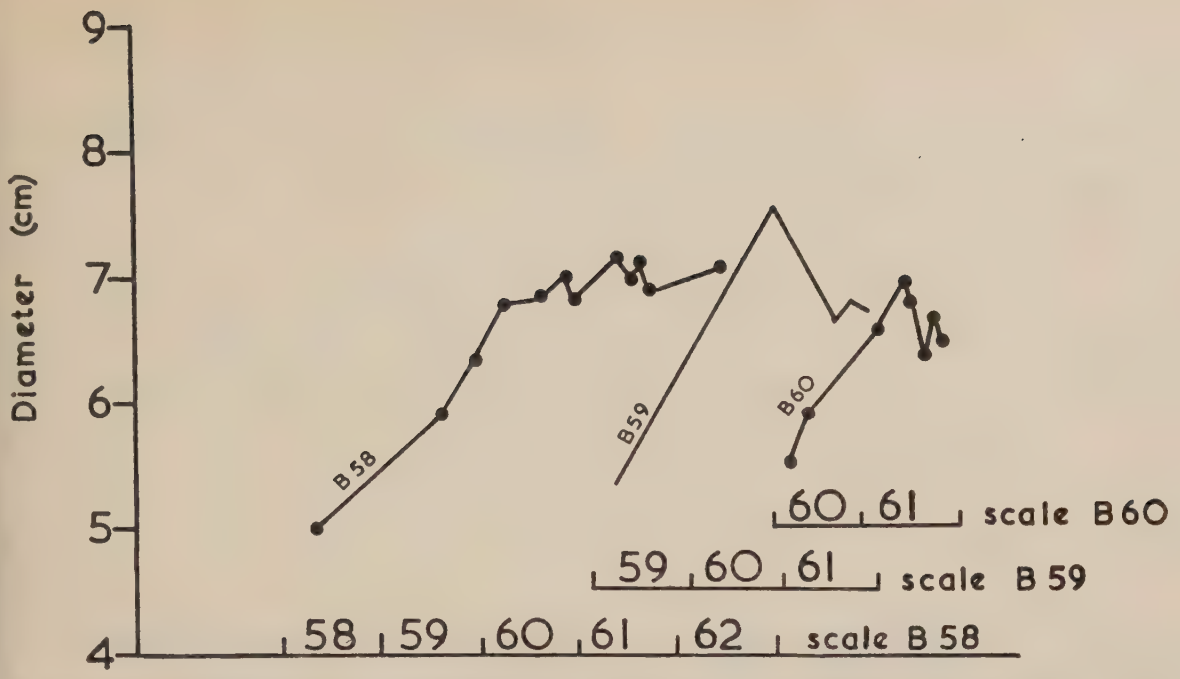


Fig. 8. Growth in diameter of French oysters relaid in Loch Ryan in 1958 (B58), 1959 (B59) and 1960 (B60).

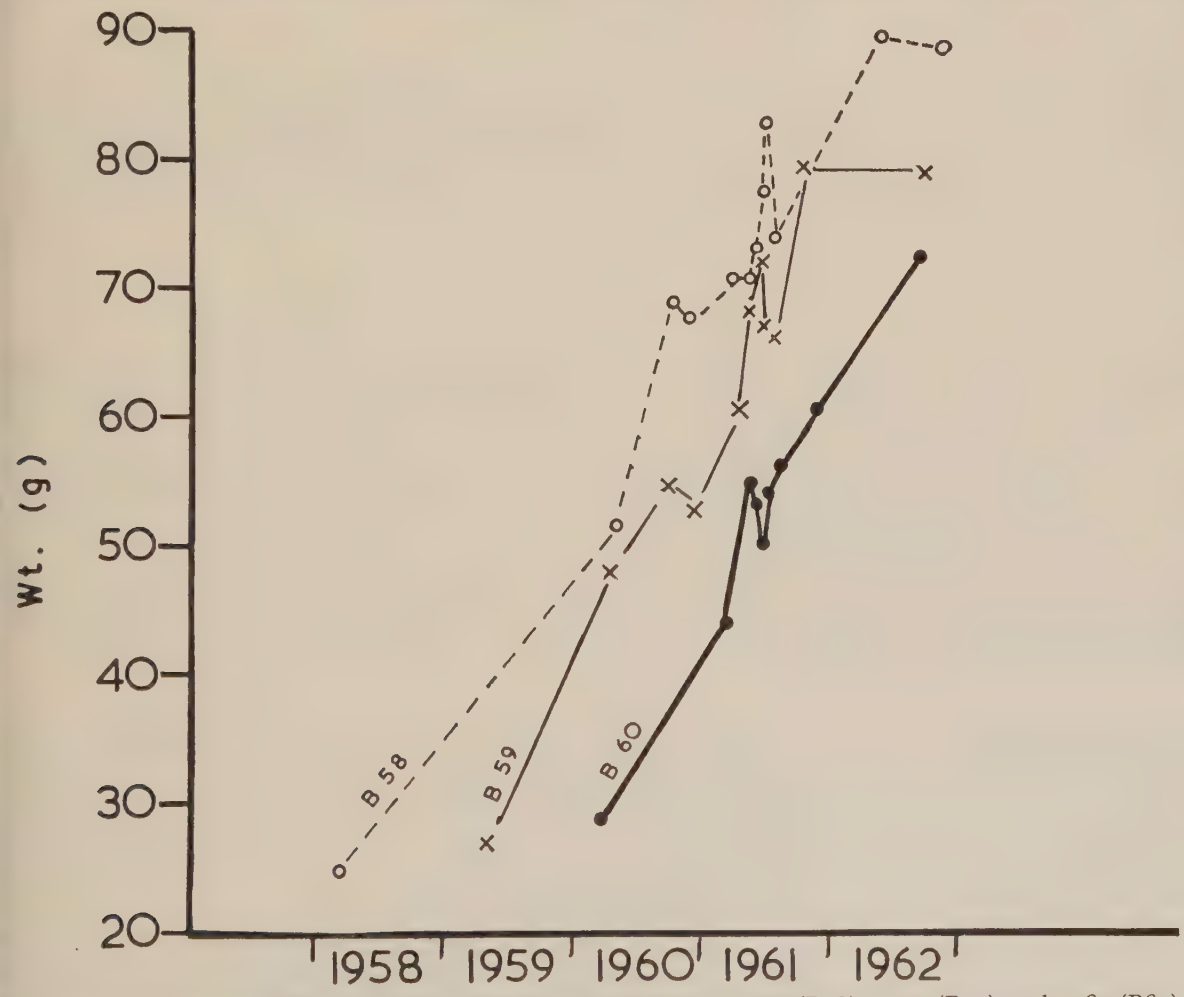


Fig. 9. Growth in weight of French oysters relaid in Loch Ryan in 1958 (B58), 1959 (B59) and 1960 (B60).

Condition

The index of condition, or condition factor, was used as in previous Scottish investigations. Results

TABLE II

INDEX OF CONDITION OF OYSTERS IN LOCH RYAN
B58, B59, 1958-, 1959- LAYINGS OF BRITTANY OYSTERS

Kind of oysters		Native	Native	B58	B59	Native	B58	B59	B59
Date sampled		30.10.58	10.12.59	10.12.59	10.12.59	21.12.60	21.12.60	21.12.60	2.11.61
% distribution of index of condition	0.39 & below	40	20	40	80	70	85	60	55
	0.40-0.44	20	55	30	20	30	25	40	30
	0.45-0.49	40	15	30	0	0	0	0	5
	0.50-0.54	0	10	0	0	0	0	0	0
	0.55 & over	0	0	0	0	0	0	0	5

from Loch Ryan (Table II) compare unfavourably with those from the best fattening areas of previous tests on the Scottish west coast (Millar, 1961, pp. 75-6).

Breeding

Breeding was studied each year by quantitative sampling of the plankton to determine the numbers and sizes of oyster larvae. It is impossible to distinguish larvae of native from those of French oysters. In 1960 and 1961 native and French adults were also sampled to find the proportion carrying larvae, and in the same years a detailed study was made of changes in the gonads, which will be described in a separate publication.

Sampling of Adults

In 1960, and more definitely in 1961, the native oysters started to breed shortly before the French oysters (Fig. 10). There also appeared to be slight differences in breeding amongst the successive layings of French oysters, the 1958-laying being earliest and the 1960-laying latest. The main breeding maximum of natives extended from late June through the first half of July, and a small second maximum appeared about the middle of August. A large first and a small second maximum are also apparent in all the other records except those of the 1958-laying in 1961. In all stocks and in both years the highest proportion of adults incubating larvae was from 20 to 30%. The only differences, therefore, that could be found in the breeding behaviour of the various stocks were a slightly earlier maximum in the female phase of native oysters, and perhaps a progressively earlier female maximum in relaid French oysters the longer they remained on the beds.

Larvae and Spat

Known quantities of water pumped through bolting silk gave quantitative samples of plankton over the beds, and oyster larvae were counted and measured in these samples (Tables III-VI). The larges concentrations were between 1000 and 1500 larvae in 1000 litres of water. Over the oyster beds in Esse the numbers are often from 1000 to 5000 (Knight-Jones, 1952; Waugh, 1957).

The period of best growth, which may lead to the appearance of eyed larvae, varied from year to year. In 1959 and 1960 this period occurred in the first three weeks of July and in 1962 in the first two weeks of August, but in 1961 growth appeared to be poor throughout the season. The poor growth in

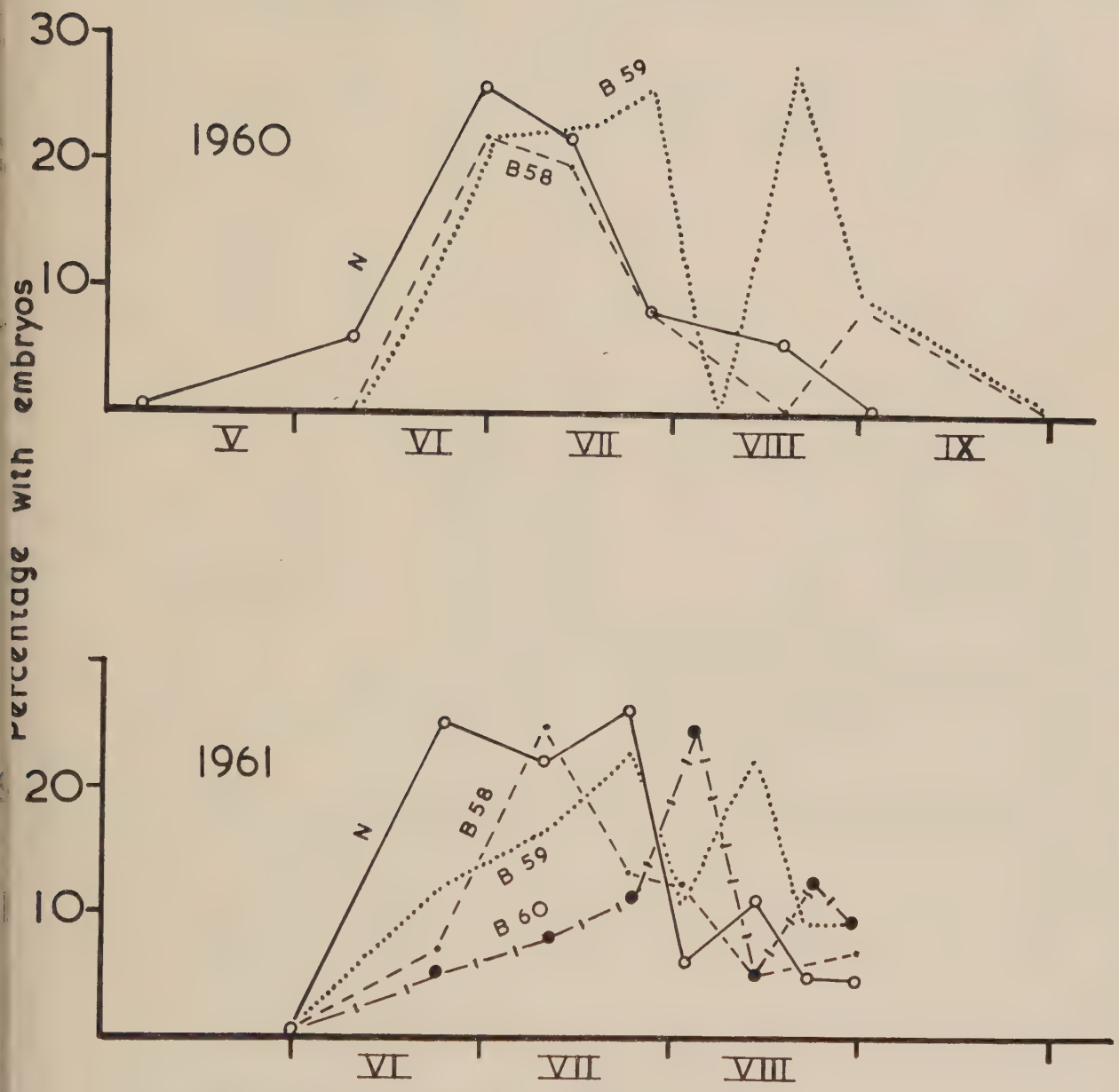


Fig. 10. Breeding of native and French oysters in Loch Ryan during 1960 and 1961, as shown by the percentage of oysters sampled which were incubating; N, native; B58, B59, B60, French oysters relaid in Loch Ryan in 1958, 1959 and 1960 respectively.

TABLE III

OYSTER LARVAE IN LOCH RYAN, 1959

Date	Depth (m)	Percentage distribution by size (mm)													% eyed	No. larvae per 1000 litres
		0·16	0·17	0·18	0·19	0·20	0·21	0·22	0·23	0·24	0·25	0·26	0·27	0·28	0·29	
6.7.59	0·5				8	21	13	25	25	8						0	126
	2·0				8	27	4	42	11	0	8					0	282
9.7.59	0·5				30	10	0	20	10	20	10					0	160
	2·0				19	25	12	20	9	12				0	3	3	238
14.7.59	2·0			2	2	10	20	18	18	14	10	0	2	2	2	4	561
20.7.59	2·0			2	27	27	18	11	5	8				2	0	2	350
22.7.59	2·0						not measured									3	192
27.7.59	2·0			8	22	29	29	12								0	130
3.8.59	2·0						not measured									0·2	1370
7.8.59	2·0						not measured									0	84
10.8.59	2·0						not measured									0	70
13.8.59	2·0						not measured									0	101
19.8.59	2·0						not measured									0	145
20.8.59	2·0						not measured									2·5	130
27.8.59	2·0						not measured									0	39
31.8.59	2·0						not measured									0	113

TABLE IV

OYSTER LARVAE IN LOCH RYAN, 1960

Date	Depth (m)	Percentage distribution by size (mm)													% eyed	No. larvae per 1000 litres
		0·16	0·17	0·18	0·19	0·20	0·21	0·22	0·23	0·24	0·25	0·26	0·27	0·29		
15.7.60	1		8	6	16	28	16	20	0	0	4	0	2		2	772
	3	4	8	12	22	18	10	10	6	0	6	0	4		0·4	1088
19.7.60	1	6	20	24	22	18	2	0	4	2	0	2			0	980
	3	22	14	19	25	18	0	0	0	0	2				0	1640
22.7.60	1	6	6	4	24	40	8	10	0	0	2				0	1528
	3		4	12	16	32	22	4	4	2	2	2			0	908
25.7.60	1	14	10	20	26	20	0	0	6	2	2				0	244
	3	8	17	15	17	30	5	3	5						0	160
27.7.60	1	66	0	0	33										0	12
	3														0	0
29.7.60	1		38	25	25	12									0	32
	3	4	4	24	28	40									0	232
1.8.60	1		33	33	33										0	12
	3			25	50	25									0	16
3.8.60	1			33	33	33									0	12
	3		33	33	33										0	12
5-15.8.60		no further oyster larvae														

Date	Depth (m)	Percentage distribution by size (mm)													% eyed	No. larvae per 1000 litres
		0·16	0·17	0·18	0·19	0·20	0·21	0·22	0·23	0·24	0·25	0·26	0·27	0·28	0·29	
26.6.61	2				5	65	30									0	100
27.6.61	2				6	64	30									0	110
10.7.61	2			4	29	59	8									0	120
11.7.61	2			2	44	47	7									0	195
18.7.61	2				17	34	34	15								0	175
20.7.61	2				20	40	20	20								0	25
24.7.61	2			7	67	26										0	910
25.7.61	2			6	54	31	9									0	290
3.8.61	2			15	28	42	15	5	5							0	260
4.8.61	2		6	35	41	9	9									0	735
16.8.61	2					50	50									0	10
17.8.61	2				33	33	17	17								0	30
22.8.61	2			9	58	24	6	3								0	170
23.8.61	2			21	27	32	5	15								0	450
30.8.61	2			20	0	0	20	60								0	25
31.8.61	2					50	50									0	10

TABLE VI

OYSTER LARVAE IN LOCH RYAN, 1962

Date	Depth (m)	Percentage distribution by size (mm)													% eyed	No. larvae per 1000 litres
		0·16	0·17	0·18	0·19	0·20	0·21	0·22	0·23	0·24	0·25	0·26	0·27	0·28	0·29	
2.7.62	1·5		25	0	25	50										0	13
9.7.62	1·5				13	68	13	6								0	20
11.7.62	1·5				13	56	25	0	6							0	20
13.7.62	1·5					50	50									0	84
16.7.62	1·5					8	38	23	15	8	8					0	37
18.7.62	1·5			6	15	52	6	15	6							0	90
20.7.62	1·5				12	61	15	12								0	768
23.7.62	1·5				10	35	22	27	5							0	121
25.7.62	1·5				13	26	22	19	16	4						0	297
27.7.62	1·5				4	21	55	4	4	10	2					0	1065
30.7.62	1·5				8	23	45	8	0	0	8	8				0	42
1.8.62	1·5				4	28	26	15	6	11	5	4	9	1		0	894
3.8.62	1.5					6	22	30	16	8	6	6	4	2		2	327
6.8.62	1·5				2	31	11	12	12	12	6	6	6	2		0	129
8.8.62	1·5				22	17	16	10	15	5	0	6	3	6		1·6	192
10.8.62	1·5					16	33	8	23	12	0	4	4			4	78
13.8.62	1·5					50	20	20	0	0	0	0	10			0	30
15.8.62	1·5					70	20	10								0	108
18.8.62	1·5				7	58	14	9	8	4						0	221
20.8.62	1·5				6	35	53	6								0	51
22.8.62	1·5				22	78										0	66
24.8.62	1·5					41	25	25	3	6						0	96
27.8.62	1·5				8	6	28	52	6							0	162
29.8.62	1·5					31	57	12								0	165

1961 may have resulted from the low temperature of the water (Fig. 2), but in 1962 larval growth was satisfactory although the sea temperature was again low. Possibly poor larval growth results from a combination of adverse conditions, such as low temperature and shortage of food.

Larvae were not equally distributed over the area, but too few samples were taken and too many factors were involved to allow a clear picture to emerge. Figure 11 summarizes the horizontal distribution

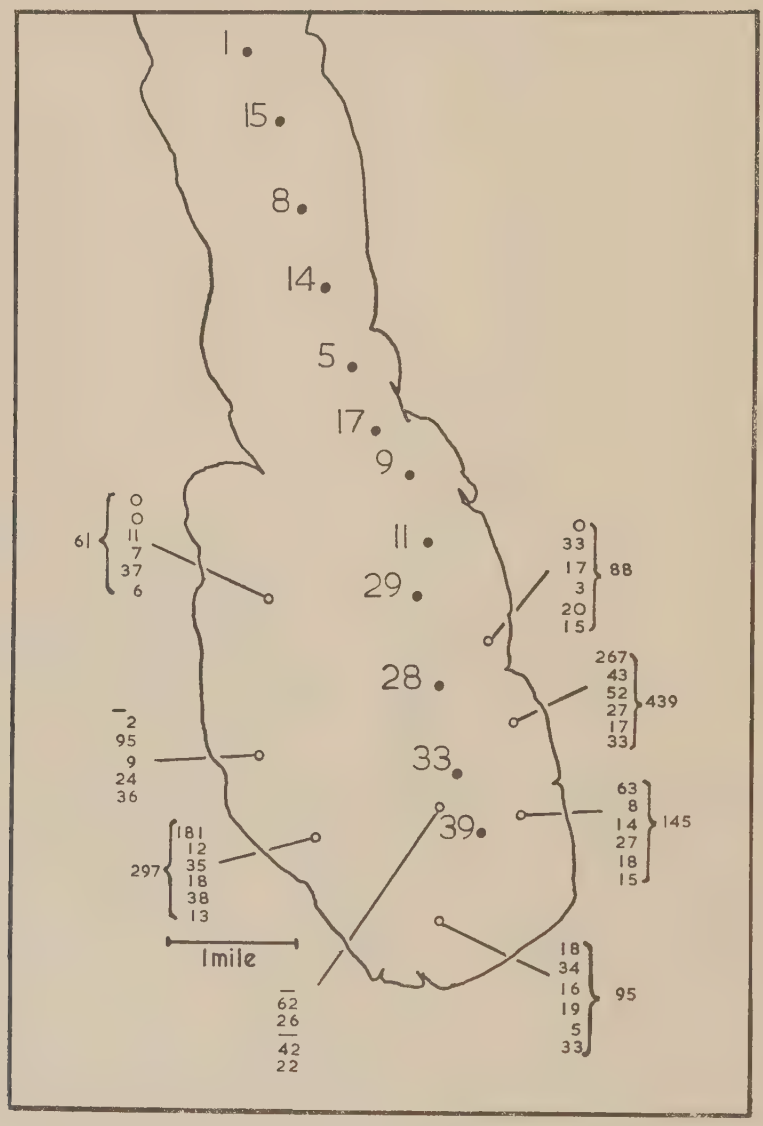


Fig. 11. Distribution of oyster larvae in Loch Ryan from pumped plankton samples in 1959; at each station (open circle) the vertical set of figures shows the number of larvae per 300 l. in a series of surveys made in July and August 1959; the totals are also given for stations where a complete series was made; figures beside closed circles show the numbers of larvae in one series of pumped plankton samples taken by "Calanus" on 13.8.1959.

larvae in several series of pumped samples taken in 1959. More larvae were taken in the southern half the inner basin than in the northern half, and they became progressively fewer towards the mouth of e loch. Numbers were low in the north-western corner of the inner basin. The larval distribution corre-onds approximately to the distribution of native oysters, but factors other than larval distribution, rticularly the availability of culch, also determine the position of spatfall and consequently the distri-ution of native oysters.

During preliminary surveys of the stock in October 1958 some observations were made on the spat-ll of that season. Five "clocks", or empty, but still hinged, pairs of shells, had respectively 0, 1, 1, 2 d 17 oyster spat, ranging from 1 to 7 mm in diameter.

Fourteen tons of mussel shell were laid, at three stations S1, S2 and S3 (Fig. 1), on 21st July 1959 experimental spat-collectors. This was too late for much settlement in 1959, but was available in 1960. small settlement was detected on clocks, however, on 3rd August 1959, amounting to 2 spat on 15 ocks examined. Also, examination of the mussel shell on 26th July 1960 showed 2 oysters of the 1959-ttlement on 165 shells examined.

TABLE VII

SPATFALL OF 1960 AND SUBSEQUENT MORTALITY

Position	Date examined	No. of shells examined	No. of shells with 1960-spat	Total no. of 1960-spat	No. of spat per 100 shells
S1	26.7.60	55	14	82	149
	18.8.60	31	4	17	55
	21.3.61	125	17	39	31
	24.10.62	162	18	22	14
S2	26.7.60	55	1	1	2
	18.8.60	10	0	0	0
	21.3.61	134	5	6	4
S3	26.7.60	55	24	41	75
	18.8.60	42	21	48	114
	21.3.61	133	44	56	42
	24.10.62	140	13	15	11

Repeated examination of the mussel shell laid in 1959 showed the spatfall of 1960 and gave an ication of the subsequent mortality (Table VII).

No settlement was detected in the summer of 1961, but the weight-distribution, obtained from a vey in July and August 1962, showed a group of oysters under 15 g, many of which were from 5 to . All the oysters in this group almost certainly settled in 1961.

In 1962 wire bags containing bleached oyster shells, hung 1 m from the bottom, were used as ex-imental spat-collectors. When examined on 7th September 1962 the shells showed the following tfall:

No. of shells examined - - - - -	75
No. of shells bearing spat - - - - -	16
Total no. of spat - - - - - -	21

In each year, from 1958 to 1962 inclusive, settlement of oyster larvae occurred, and direct observation of spat was confirmed by the year-groups apparent in the weight-histogram of the stock in 1962 (Fig. 7B).

Growth of the spat which settled in 1960 can be followed from Figure 12. At the age of 27 months about half of these young oysters were large enough to be planted out direct on the bottom.

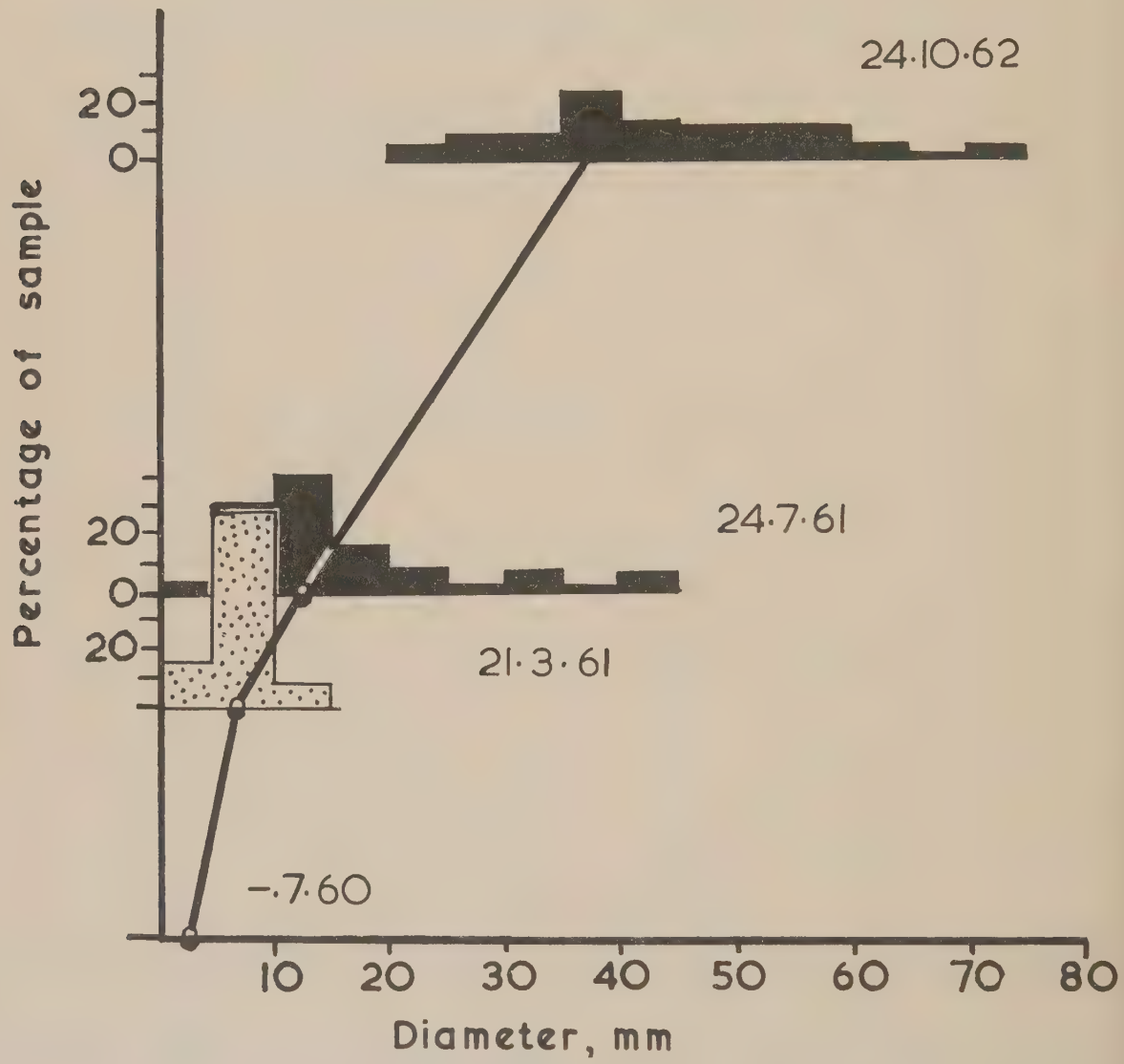


Fig. 12. Growth of oysters which settled as spat in 1960; the modal diameters of successive samples are joined to give a growth curve.

Mortality among French Oysters

The mortality amongst the relaid French oysters was assessed by counting the number of living oysters and paired dead shells in samples dredged at intervals after laying (Table VIII). With this

TABLE VIII

MORTALITIES IN RELAID FRENCH OYSTERS IN LOCH RYAN

Laying Date sampled	1958	1959	1960
2.6.59		6.6	
22.7.59	15·9		
12.8.59	18·8	3·5	
5.5.60	9·0	3·8	
26.7.60	8·7	5·6	
6.10.60	22·0	2·1	
21.3.61	15·0	1·4	2·8
13.12.61			6·5

Cumulative percentage mortality

other inexact method results are not consistent, but are probably reliable enough to suggest that annual mortality was less than 7% in the 1959- and 1960- layings and rather higher in the 1958- laying. On all layings, however, it was lower than on most commercial grounds, where losses of up to 30% are to be expected in the first year after laying (Cole, 1956).

CONCLUSIONS

The inner basin of Loch Ryan presents a large expanse of shallow water giving sufficient shelter both for oysters on the bottom and to boats working the beds. The soil varies a little but large areas are level, free of obstructions and uniform in texture. The whole of the bottom of the inner basin can support relaid oysters, but the central area consists of rather soft mud.

Native oysters still survive and, indeed, have increased from 1958 to 1962, mainly because there has been no commercial fishing during the experiments. A spatfall was demonstrated in each year of the observations, but there is little doubt that the marked scarcity of shell and other culch on the bottom seriously limits the extent to which the annual spatfall can increase the stock. Any attempt to revive commercial fishing should, therefore, include the provision of some form of culch or artificial surface to collect more spat. Even with the existing breeding stock the regular, if rather small, spatfalls would be beneficial to a fishery. Bigger spatfalls should result from a larger breeding stock, which might be provided by the relaying of a few million French oysters. It was found that French oysters laid in Loch Ryan freely produced larvae but it is not yet known whether these larvae grow and settle as successfully as the larvae of native oysters. If they do, French oysters relaid for growing and fattening will serve also as additional breeding stock.

French oysters relaid in Loch Ryan have shown moderate growth in their first two years. Little subsequent increase in diameter is to be expected, although the weight continues to increase slowly. The condition of these oysters is inferior to that of French oysters relaid in areas found to be satisfactory elsewhere on the Scottish coast. Nevertheless relaid French oysters would yield a marketable product, though not of so high a quality or so quickly produced as those from the best commercial grounds. One favourable aspect is the scarcity of predators and the consequent low mortality amongst relaid stock, features which, to some extent, offset the moderate quality of the area as a growing ground. Other advantages are the ease of working dredges over the whole bed, the proximity of a harbour and railhead and the large area available for expansion. These, together with the breeding potentialities, make Loch Ryan one of the best sites in Scotland for a commercial oyster fishery.

SUMMARY

The physical and biological conditions on the oyster beds in Loch Ryan are described. French oysters were introduced, their growth and mortality were studied, and their breeding was compared with that of native oysters. Loch Ryan is considered one of the most suitable Scottish areas for a commercial oyster fishery.

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APPENDIX

NO. OF SPECIMENS PER 1 SQ. M OF SOME SPECIES OF THE BOTTOM FAUNA IN LOCH RYAN, TAKEN BY VAN VEEN GRAB

Station No.	*Nucula turgida*	*Ostrea edulis*	*Thyasira flexuosa*	*Dosinia lupinus*	*Venus striatula*	*Spisula subtruncata*	*Abra alba*	*Abra nitida*	*Phaxus pellucidus*	*Corbula gibba*	*Turritella communis*	*Amphiura chiajei*
1			31		2	1	54	75			61	
2			15		3		13	70	1		64	
3			1	1	1		8		1	1	127	
4	2		10		1		9	9			?	
5	1		11		5		94	3		2	3	1
6			35	2	1		9	52			253	1
7	1		12		3		5	13		1	185	
8			9				5				123	
9			9		1		80					
10			24		3	1	15	17			243	
11	1		26		3		12	4		1	305	
12			15								27	
13		3	3		4	1	8	2		1	32	2
14			5		1		1	2		2	223	3
15			3		1	1	24			2	47	
16			13		3		62	9			30	
17			12	1	2	1	18	14		2	357	
18			11	1	1		6	68		2	587	
19		1	15		3		1	5	1	3	60	
20			12	1		3	7	15		3	305	
21			3		6		55	8			15	
22			5		7		23	10		1	418	
23		11	4	2	2			5		1	309	5
24			15		6		11	17			5	
25			7		1	1	16	21			415	1
26			27		2		3	73		1	692	
27			34		12	1	3	29		1	234	1
28			18		2		14	36		3	69	1
29			6	1	2		2	57			83	
30		1	5		4	4	1	13		1	64	
31	1		8		1	1	8	28			42	1
32			10		4		2	29		2	435	
33		2	14		6	1	3	11	1	7	230	
34			18			4	34	714	1	11	?	
35				12			15	109			82	
36	1		15				11	26			14	
37		7			4		17			1	16	1
38	2	11	28		4	14	28	90		4	131	2
39			13			53	16	82		6	159	1
40	2		123	1	13	129	357	549		16	?	
41			9		3	7	22	70	1	1	214	
42			21	1	9	36	50	45	2	3	290	
43			2		3	1	2	3		6	3	
44	1	2	10		3	50	35	29		12	230	1
45			35	1	4	59	57	48		4	101	
46			20		15	122	22	29		15	118	
47			3		2		22	72			13	
48			3		5	53	4	8		5	75	
49			17		18	108	23	16		15	54	

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